The Meteorological Magazine

Air Ministry :: Meteorological Office

Vol. 60

July 1925

No. 714

LONDON · PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE.

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The New Edition of Exner's Dynamische Meteorologie

By Sir GILBERT WALKER, C.S.I., F.R.S.

THE appearance of the second edition of Exner's *Dynamische Meteorologie* forms a big landmark in the development of the subject. In the first edition—completed in 1915—a most successful effort was made to put together all that was then known about the theory of air movements; and while the work of Exner himself rightly and inevitably occupied a large place, justice was done to the fundamentally important work of Margules, which was drawn "as a red line" through the book. The last ten years have seen important developments in our science: the striking successes of Bjerknes and the Norwegian school have in England, to some extent, attracted attention away from the equally important advances made by the Austrian and the Lindenberg schools, and it is most fortunate that we have now available a systematic account of what is known, from the dynamical standpoint, of the problems of general meteorology and the phenomena of the atmosphere as a whole.

In the first chapter—on the laws of gases—are discussed the relations between the pressure, temperature and density of air containing moisture in its various forms, with Bezold's "pseudo-adiabatic" changes. In Chapter II. we find the general equations of motion of the air on the rotating earth; the horizontal deviating force thereby produced is, of course, that known in England as the geostrophic force; but the vertical component, by which an eastward moving body is lighter than a westward,

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is as large at the equator as the horizontal component; and though its direct effect may be merely to alter pressure, the inequality of this will affect the horizontal velocity. The next chapter—statics of the atmosphere—is concerned with relations between pressure, temperature and height in the atmosphere. The more physical treatment begins in Chapter IV., on the vertical temperature distribution in equilibrium; Exner remarks that on summer afternoons in the lower layers labile equilibrium, with potential temperature diminishing with height, is not only occasional, but is the rule. The vertical motion set up is slow enough for the temperature differences between the ascending or descending masses of air and its environment to be partly smoothed away; in place of a violent upheaval there may result merely a stationary circulation provided that the masses of air involved are not too large, as the exchange of heat is proportional to the surface, and the heat content to the volume of the mass. Exner next examines the effect, upon the vertical temperature gradient of a thin layer of air, of an ascent or descent of the whole layer, whether the temperature gradient within it is stable or not for the ascent of small masses of air: he shows, for example, that the descent of a layer of air with a gradient of 5° a kilometre from $5\frac{1}{2}$ kilometres to sea level will produce a uniform temperature in it. This is followed by an excellent account of the effect of conduction and radiation in producing the troposphere and stratosphere, and in particular of the work of Humphreys, Emden and Hergesell on the subject.

Chapter V. (kinematics) begins with Bjerknes' work on stream lines, and discusses the effect on the temperature in ascending or descending air when it moves inside a stream-tube of varying section: clearly such variation occurs whenever air ascends or descends in a column terminating near the ground, and the effect is appreciable.

In Chapter VI.—on the general dynamics of air movements—we have Helmholtz' analysis of the effects of dimensions on similarity of air movements; and then a discussion of some simple cases of motion without and with friction, the former including an interesting stationary motion of wave-like character, and the latter several new pieces of analysis due to Sandström, Hesselberg and Sverdrup. There follows "turbulence" or "exchange" as developed simultaneously by Taylor and Schmidt, and subsequently by Richardson. Developments by Gold, Köppen and Hesselberg are introduced, with an important and elegant theorem by Bjerknes extending Helmholtz' theorem regarding circulation. Vertical motion is then discussed, and the exchange of heat between the earth and moving air.

The energy of air movements is handled in the seventh chapter, such movements being maintained either by loss of potential

energy or by absorption of heat in a warm region and losing it in a cooler one. Much of our knowledge is due to Margules, who found a source of the energy in a cyclone in the potential energy of a mass of warmer air originally not entirely above a mass of colder air, the colder air subsequently spreading out in a layer below the warmer: he also examined the effect of latent heat and a transfer of heat as a source of energy for steady motion. Exner has here made considerable advances, and Sandström has investigated the continuous production of energy in vortices: for example, he finds a large horse-power produced on the north-west coast of Norway in winter by a cold seaward current above which is a warmer current. Exner also works out an approximate solution for land and sea breezes.

Chapter VIII., under the title "Stationary streams in the atmosphere," begins with Margules' handling of horizontal falls of temperature with stationary motion, and Bjerknes's determination of the inclination of surfaces of discontinuity.

The general circulation is treated in Chapter IX., and for the qualitative explanation reference must be made to paragraph 61: the very important conclusion is reached that in higher latitudes the general circulation must resolve itself into a consecutive series of circulations such as are observed in cyclones and anticyclones. In paragraph 64 a first effort is made to work out the transport of heat between lower and higher latitudes in connection with the heat received from the sun and radiated into space. Exner points out that there can be no stationary motion when gradients have different directions at different heights above the same place; for when the flow along the gradients leads to changes of temperature changes of weather must follow: and, accordingly, in a chart of the northern hemisphere (p. 243) the regions where isobars and isotherms cut at right angles are characterised by the frequent development of cyclones. The section on long-lasting anomalies in the general circulation contains some ingenious and valuable generalisations from collections of correlation coefficients; in the polar region temperatures and pressure both fall with an increase of the general circulation, while in latitude 20° N. pressure rises, the coefficient with polar pressure being as high as −·74.

In the tenth chapter we have accounts of investigations into the dynamics of cyclonic movements by Fujiwhara, Emden, Helmholtz, Guldberg and Mohn, Oberbeck and others. The interest tends to be more mathematical than physical, for a cyclone does not appear to assume a figure of revolution symmetrical on all sides until its activity is decreasing.

Non-periodic changes at a single place in the atmosphere (Chapter XI.) depend on the relations between the pressure and temperature conditions in a vertical line through the place,

and the discussion of these is a model of clearness. The question is still regarded as open, whether the actual changes of pressure on the ground are due merely to temperature changes or not (p. 290). Exner then discusses the effects of " advection " on change of pressure and temperature, and applies the method to forecasting changes in the weather map. Finally, we have a statement of the important relationships derived by Dines and by Schedler between the pressure at the ground and at 9 kilometres, the height of the troposphere, the mean temperature of the lowest 9 kilometres, and the temperature at the tropopause ; and an able summary of the explanations that have been put forward.

Perhaps the most characteristic chapter is the twelfth—non-periodic changes in synoptic representation. Originally treated as a continuum, the air has during the past 20 years been more and more regarded as divided into parts which may be called " air-bodies," such that within one air-body all separate particles of matter are interchangeable. In dry air the potential temperature in an air-body is uniform, and it is only by a gain or loss of heat (or by condensation) that a fragment of air can leave its air-body. The surfaces of discontinuity between air-bodies are of vital importance, but will only remain constant in position when certain conditions are satisfied. The onrush of a mass of cold air has been elucidated by Köppen, Margules, Ficker and Schmidt, as well as by Exner, and the cold waves of Russia and Siberia lend themselves to quantitative treatment. The origin of cyclones extending up to a few kilometeres in height is then discussed, and after pointing out how eddies due to the west wind will form to the east of S. Greenland and produce an area of low pressure there, Exner describes how cyclones will form to the east of a wave of cold air acting like a barrier. Bjerknes' theory of the production of a cyclone by the interaction of cold and warm streams is fully discussed. For areas of high and low pressure extending up to the stratosphere Exner assumes that the explanation lies in the temperature conditions high up ; and holds that a high anticyclone is due to a southerly stream which is warm below and extends up to the stratosphere to which it brings cold. A theory regarding the changes of the daily weather charts concludes the chapter.

The last chapter deals with periodic changes. The time-changes in air movements will depend partly on the distribution of the air itself and partly on the distribution of land and sea. The first influences which would persist if the earth's surface were uniform can scarcely produce regular fluctuations apart from the oscillation of the atmosphere as a whole (see below) ; and the explanation of local oscillations must therefore be sought in geographical data. By a rough approximation Exner finds

a period of 25 days with its sub-periods, which agrees well with Defant's determination for the northern hemisphere. Waves due to gravity and relative velocity at the interface of the media are discussed, and finally we have Margules' great work of the daily periods of wind and pressure of the air as a whole treated as a thin shell, and on its free elastic oscillations, which though published in 1892 seem to have been overlooked for a long time in England; such analysis is of course of vital importance in connection with the half-daily period of pressure.

The author is equally conspicuous for his wide knowledge of the literature of the subject—to remember his own contributions must have been no easy task—and for the clearness and sound judgment with which he presents his materials. The book is essential to all serious students of meteorology.

OFFICIAL NOTICE

Beaufort Weather Letters b, bc, c and o

The letters b, bc, c and o have been used for many years in the Meteorological Office as equivalent to certain definite amounts of cloud, and they have also been used in this sense by observers in the weather columns of the returns which they have supplied to the Office.

The last edition of the *Observers' Handbook** states :—

b—Blue sky, cloudless.
bc—A combination of blue sky with detached clouds.
c—Sky mainly cloudy, but with openings between the clouds.
o—Completely overcast.

and adds " These letters are intended to refer only to the amount of cloud visible, and not to its density, form or other quality. They have come to be regarded as corresponding to the cloud amounts in the scale o—10 :– b = o to 3, bc = 4 to 6, c = 7 or 8, o = 9 or 10."

Various difficulties have been experienced with this definition. For example, the conventional numerical definitions of b (viz., o to 3 of cloud) and of o (9 or 10 of cloud), may be at variance with the verbal definitions; again it seems incongruous to describe as o a sky covered with thin cirrus haze, while a sky four-fifths covered with heavy nimbus is called c. The precision implied by a fixed table of equivalents is also a difficulty; for, on the one hand, if present weather is being reported the

* 1921 Edition, p. 51-2.

information conveyed by the letters b, c or o is repeated in the column headed "cloud amount," while on the other hand if past weather is being reported, few observers are in a position to keep the continuous watch on the sky which the numerical definition really demands.

It appears that some observers (and especially marine observers) still use the letters more or less in the original sense, as intended by Admiral Beaufort; that is, they use them to describe "the appearance of the sky" and not merely the total amount of cloud. It seemed worth while, therefore, to attempt to discover exactly what the original significance of the letters was. As a result of a study of the original documents and logs of Admiral Beaufort it has been decided to revert (as nearly as possible) to the original definitions of the letters, which are as follows:—

(Beaufort's third log 1833-41).

b—Denotes blue sky whether with clear or hazy atmosphere.
c—Cloudy, i.e. detached opening clouds.
o—Overcast, i.e. the whole sky covered with one impervious cloud.

In order to carry out this policy the following Order has been issued from the Meteorological Office:—

Beaufort Notation of Weather—

The following definitions of the Beaufort Weather Notation will in future be adopted in Office practice.:—

Appearance of Sky—

b—Blue sky, whether with clear or hazy atmosphere.
c—Cloudy, i.e. detached opening clouds.
o—Overcast, i.e. the whole sky covered with one impervious cloud.
g—Gloomy.
u—Ugly, threatening.

The letters, b, c, o, g and u, are used to describe the general appearance of the sky.

The use of the letters g and u is sufficiently clear from the definitions given above. The following remarks apply to the use of the letters b, c and o.

o is used whenever the sky is completely overcast with a uniform layer of thick or heavy cloud; c is used to denote that there is some cloud present but o is not appropriate; b denotes that there is some blue sky.

In order to meet difficulties which occur when there are only small quantities of cloud or blue sky present, it has been decided that c shall not be used unless the sky is more than a quarter covered, and b unless there is more than a quarter of the sky free from cloud.

If there is both blue sky and cloud (with the above limitations) b and c will both be recorded.

The definitions given above will be introduced into the *Observer's Handbook* and other official instructions to observers as each comes up for reprint. Such alterations of current procedure at Headquarters or at Observatories and Outstations as are involved in this order will be made as from 1st January, 1926.

The spirit of these rules can perhaps be best explained by stating that the letters are intended to indicate the general effect which the appearance of the sky produces upon the observer's mind. This effect is frequently so well-defined that it is unnecessary to look at the sky in order to apprehend it, although no meteorological observer should be content to treat the matter in that way. It is an effect which any layman knows and appreciates without perhaps being able fully to describe it. The rules are intended to ensure that there is a standard of uniformity in the matter in the official reports.

It will be observed that there will be no set table of equivalents between Beaufort letters and cloud amount. Such a table would be inappropriate because it would imply greater precision than is generally practicable, and would also suggest that the letters are not concerned with any other quality than the amount of cloud. Under these rules a sky completely covered with cloud is classed either as c or as o after reference to other attributes of the cloud, such as uniformity and density. The use of o will therefore be less frequent than hitherto, while c will be more frequent.

The letters g and u may be used either alone or in association with the letters c and o to describe more exactly the appearance of the sky, while it is possible that u may also be used with b, for example, during the approach of a thunder-cloud.

The following examples of the use of c and o may be of service :—

(1) Sky covered or practically covered with high cloud. Entry c not o, as the cloud is not impervious.

(2) Sky quite covered with one kind of heavy cloud, the covering being however composed of separate clouds. Entry c, not o, as there is more than one cloud.

(3) Sky covered with two kinds of heavy clouds. Entry c, not o, for the same reason as in (2).

(4) Sky covered with alto-stratus of the thick variety. If the sun can be seen the cloud is not impervious and therefore c would be used. Occasional alto-stratus is sufficiently thick for o to be appropriate. The observer must decide which letter to use.

(5) Sky covered with thick stratus cloud. Entry o.

OFFICIAL PUBLICATIONS

The following publications have recently been issued:—

GEOPHYSICAL MEMOIRS.

No. 25. *Surface and Geostrophic Wind Components at Deerness, Holyhead, Great Yarmouth and Scilly.* By S. N. Sen, Ph.D. (No. 254*e*.)

This paper discusses the seasonal and annual variation of wind speed at the four chief anemograph stations of this country, with special reference to the development of the land and sea breeze on the east coast during the summer months. Wind data of a technical nature are also given. The main results are illustrated by means of diagrams.

No. 26. *Classification of Synoptic Charts for the North Atlantic for* 1896-1910. By E. V. Newnham, B.Sc. (No. 254*f*.)

Synoptic forecasting is still mainly an empirical science, and, although its position in this respect has been modified somewhat of recent years, the forecaster has to be guided very largely by his experience of what has happened before under similar conditions. When he is confronted by some particular distribution of pressure he requires a ready means of reference to similar distributions which have occurred in the past. Some years ago Col. Gold* classified the daily weather maps of western Europe into types for this purpose. Wireless messages now enable the daily weather chart to be drawn over a large part of the North Atlantic as well as over Europe and the neighbouring islands, and the present memoir, which classifies weather charts into types according to the pressure distribution over the North Atlantic and Europe as whole, provides a similar classification, but extending over a wider area. The basis of the classification is the position of the anticyclonic centres, which, being more permanent than the depressions, give the more durable features of the distribution.

PROFESSIONAL NOTES—

No. 40. *The Ground Day Visibility at Cranwell, Lincolnshire, during the period* 1*st April,* 1920 *to* 31*st December,* 1923. By W. H. Pick, B.Sc. (No. 245*t*).

No. 41. *Upper Air Temperatures in Egypt.* By E. V. Newnham, B.Sc. (No. 273*a*).

Mr. Stanley Single reports that he observed the Green Flash at sunset on March 28th, 85 miles south-east by south of St. Helena—the only occurrence during a five weeks' voyage.

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* Aids to Forecasting: Types of Pressure Distribution. By E. Gold, F.R.S. *Geophysical Memoirs*, No. 16, London, 1920.

Royal Meteorological Society

THE monthly meeting of this Society was held on Wednesday, June 17th, at 49, Cromwell Road, South Kensington, Capt. C. J. P. Cave, M.A., President, in the Chair.

J. E. Clark, I. D. Margary and R. Marshall—Report on the Phenological Observations in the British Isles from December, 1923, to November, 1924.

Although in this, the 34th Report (New Series), 365 sets of records were discussed as compared with about 120 before 1922, yet, in north-west Ireland and most of west and north Scotland, there are still very few records, and observers are badly needed. Records of great value kept by the Marshams of Stretton Strawless, almost without a break since 1736, have been discovered this year, and responses have been received from many parts of the world to the appeal for the need of universal, more or less, co-operative systematic observations. The records of plants, insects and birds were erratic during the spring, but most things were much later than in 1923. On the 30 years' average, flowers in the east and south-east were one or two weeks late and in north England and Scotland still later, yet the hazel was early. Insects appeared late, the delay ranging from 18 days late for the honey bee, to three, only, for the Orange Tip; the migrants were also late. Lateness and wet did not, however, cause poor blooming, that and vegetable growth being exceptional and little troubled by insect pests.

D. N. Harrison, B.A., and G. M. B. Dobson, D.Sc.—Measurements of the amount of Ozone in the Upper Atmosphere.

The amount of ozone in the lower atmosphere is negligible, but in 1920 Fabry and Buisson found by spectroscopic methods that in the upper atmosphere ozone is present to an amount equivalent to a layer of pure gas three millimetres thick at normal temperature and pressure. The present paper deals with the results of measurements on about eighty days, with a simple spectroscopic apparatus designed to give a ready measure of the brightness of the spectral lines. Comparison of the results with barometric pressure at the surface shows that the amount of ozone is much greater under cyclonic than under anticyclonic conditions, and there are indications that the amount is still more closely connected with the conditions at about 10 km. and with the height of the base of the stratosphere.

J. Baxendall—Meteorological Periodicities of the order of a few years and their local investigation; with special reference to the term of 5·1 years in Britain.

Mr. Baxendall adopts as his criteria of the reality of a periodicity its appearance in the harmonic analysis of each of several

meteorological or quasi-meteorological records, and, where any of these records are sufficiently lengthy, its appearance at very nearly the same phase in each half of the record. He has found in the British Isles six definite meteorological periodicities between the limits of $1\frac{1}{2}$ and $6\frac{1}{2}$ years which satisfy these criteria, namely those of 5·1, 3·1, 2·8, 2·4, 2·2 and 1·63 years. Other periodicities which are well-supported but which are not dominant in the British Isles are those of 6·2, 5·6, 4·8, 4·37, 3·98, 2·55 and 1·9 years. The various records in which these have been found by different investigators are discussed and their possible relations to one another pointed out. The greater part of the paper deals with the periodicity of 5·1 years, which was first found at Southport and which is particularly intense in the north-west of England, but which occurs also in the records from London, in the wheat prices of western Europe, and in the velocity of the south-east trade wind at St. Helena. This periodicity is particularly well shown in the duration of winds from north or north-east both at Southport and Greenwich and in the phenomena, such as severe winters, which depend on these winds.

Correspondence

To the Editor, *The Meteorological Magazine*

Isle of Wight Weather in the 17th Century

In reference to the article in the June issue of this magazine respecting variations in the rainfall of Great Britain, it may be well to put on record the following statement in regard to rainfall in the Isle of Wight in 1648. The note was written by Sir John Oglander, who was deputy-lieutenant of the Island at that time, and the manuscript is now at Carisbrooke Castle Museum. I am not aware that it has been published, excepting in a local newspaper. The original spelling, punctuation, etc., is followed. It reads:

> "In a booke of myne wherein Parliament Busines is wryghten, you may see that I have wryghten downe all the passages of note since his Matie came into our Island. This Sommer of the Kinges beinge here 1648: wase more like winter then Sommer, for his Matie asked me wheather that weather wase usual in our Island I tolde him this 40 years I never knew the like before, wee had scarse 3 drie dayes togeather but rayne hygh windes & stormes. In Awgust we had not one drye daye, so that the corne wase like to rotte in ye ground. Deus avertat."

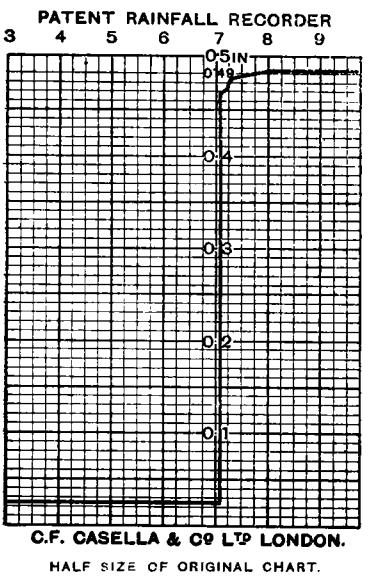
Another note by the same observer, published in the *Oglander Memoirs*, W. H. Long, 1888, runs:

> "1627. Owre harvest, by reason of ye coldness of ye summor, and ye greate fall of rayne in August and September, wase not inned till Michaelmasse, and soome long after; mutch barlie wase spoyled, and almost all ye ffatches."

FRANK MOREY.

Newport, Isle of Wight. June 29th, 1925.

Rainfall of Very Rare Intensity



HALF SIZE OF ORIGINAL CHART.

IN your issue for March, I note Mr. F. J. Varley suggests that no recording apparatus has yet been designed which is not "smothered" by heavy rain. If by "smothered" he means that the actual trace on the chart follows materially after the rainfall, I think the enclosed photo tends to disprove this; for it shows an accurate record of the phenomenal fall of ·47 in. within 150 seconds. The fall occurred during a terrific thunderstorm at 7.5 p.m. on July 14th, 1917, and the slight curve at the top of the trace was merely due to a few hailstones which took some little time melting, hardly a matter for surprise as some of the hailstones I measured on the ground were nearly 4 inches in circumference and over an inch in diameter. The trace on careful measurement exactly confirms independent observation that the storm lasted just 2½ minutes, and the quantity gauged was exactly confirmed by an ordinary "Snowdon" rain gauge a few feet away.

JOHN H. WILLIS.

Southwell Lodge, Ipswich Road, Norwich. May 8th, 1925.

[A brief description of this storm is to be found in *British Rainfall*, 1917, p. [34], and a description of the Casella Patent Rainfall Recorder used, in *The Rainfall of the British Isles* by M. de C. S. Salter, p. 72.—ED. *M.M.*]

The Snowless Winter of 1924-925

DURING the past winter the ground has not once, even for a few minutes, been white with snow at this station (200 ft.), a thing unparalleled in my recollection. Snow has never lain below 700 ft.

What makes this even more remarkable is that this is not a flat district, and in about half an hour's walk one can stand at 1,200 ft.

Above 2,000 ft. there has been a considerable amount of snow although it was practically confined to the month of February. The Black Mountains were continuously pure white above 2,100 ft. from February 11th to March 6th with twelve to eighteen inches of snow. All of this came with winds from south to northwest and much drifting occurred even when no snow was falling, the snow blowing off the flat summit plateau (2,600 ft.) into the corries on the northeast side about 2,300 ft. So huge were the cornices in these corries that on visiting them on March 19th, I found that a small avalanche had occurred in one place. Although March and April provided nothing to augment the drifts—only occasional light sprinklings on the tops—one of the drifts was still visible from here, 14 miles, on May 6th, so we may assume that those formed in February lasted at 2,300 ft. till at least the second week in May.

It would be interesting to know the date of the disappearance of the late Mr. J. R. Gethin Jones' "Latest Snow Spot" on Carnedd Llewelyn.* Doubtless this will not be before mid-June, though in 1912 I remember it melted on May 8th, the day I visited it with Mr. Jones.

My "Weather Correspondent" at Fort William, who reports to me monthly, writes under date, May 4th, that the snow level on Ben Nevis was about 2,000 ft. and that the depth on the summit was about 15 ft., which I believe is a greater depth than was ever recorded while the Observatory was in existence.

I may add that I went up the Black Mountains again on May 12th and found the last bit of the drift in a corrie 3 yds. by 2 yds. by 1 foot deep; it probably melted on May 14th or 15th. The temperature at 2,660 ft. was 49° (when sun in) and maximum here as high as 65°. The 2,660 ft. temperature was taken at 3.15 p.m. (B.S.T.). R. P. DANSEY.

Kentchurch Rectory, Hereford. June 6th, 1925.

[The Rev. R. P. Dansey has since informed us that this year the "Latest Snow Spot" on Carnedd Llewelyn was visible from 18 miles distant until June 15th. Mist on the hills then supervened, and on the 19th there was no snow to be seen from that distance. Ed. *M.M.*].

Are Winters Changing?

I HAVE read with a good deal of interest the letter of Chas. Harding, headed "Are Winters Changing," and I was present at the meeting he refers to when Sir Richard Gregory gave his able presidential address on "British Climate in historic times."

* *Symons's Meteorological Magazine*, 54 (1919), p. 66, and *British Rainfall*, 1909, p. 46.

In that address he dealt not only with average temperature but also with the practical effects of severe winters in the production of ice. It seems to me that this is a true measure of the severity of the coldest spell of weather in each winter. Sir Richard Gregory gave particulars of years when the Thames had been frozen over and also of the number of days in certain winters when there had been skating ice on the waters of the London Skating Club.

We have in the area of the great Fenland of England a rough and ready means of comparison in the power of ice production of the winters say for the 25 years ending 1895 and the 25 or 30 years since 1895. The fact to which I would invite the attention of meteorologists is that, during the 25 years ending 1895, all the main rivers in the Fenland bore on several occasions. The ice on them was sometimes so strong that skating matches attended by many thousands of skaters were run on them. Whereas since 1895 none of them, with the possible exception of the Welland, have afforded good skating ice for more than 3 or 4 consecutive days, if even so much.

I have records as under :—

1870-71—Skating match on the Ouse at Littleport.
1874-75—Skating on the Hundred Foot and a skating match on the Ouse at Huntingdon.
1879-80—Splendid skating on the Hundred Foot.
1880-81—Skating on the Cam and Ouse from Cambridge to Denver Sluice (33 miles).
Skating on the Witham, Boston to Lincoln (about 31 miles).
Skating on the Welland, Crowland to Spalding.
1890-91—Skating on the Cam and Ouse, Cambridge to Denver Sluice.
Skating on the Witham, Boston to Lincoln.
Skating on the Nen, Peterborough to Guyhirne.
1894-95—Skating on the Cam and Ouse, Cambridge to Denver Sluice.
Skating on the Nen, Peterborough towards Guyhirne.

The above records are not complete.

After making all allowance for variation in the strength of the current in different seasons, the conclusion seems inevitable — that the spells of cold in the skating months December, January and February, were much more severe in the quarter of a century ending 1895 than in the succeeding quarter of a century. Indeed during the latter period, opportunities for skating have been so few that large numbers of the younger generation have not learned to skate well.

S. SOUTHALL BURLINGHAM.

81, *High Street, King's Lynn. June 21st*, 1925.

WITH reference to the letter headed "Are Winters Changing," Mr. A. H. Hookham, of Eastbourne, has pointed out that it is not sufficient to take mean temperatures only, but that maximum

and minimum temperatures should be considered separately before arriving at a definite conclusion. From the following table it will be seen that, in the winter months, the maximum temperature at Eastbourne has increased during the 30 years under consideration and that in the summer months the minimum temperature has decreased. If mean temperatures only were considered the latter fact would be masked. The sea temperatures also show a tendency to increase in the winter and decrease in the summer.

10 years average.	Winter Months.			Summer Months.		
	Max.	Min.	Sea.	Max.	Min.	Sea.
1892-1901	49·1	40·0	46·2	62·6	51·3	58·1
1902-1911	49·3	40·2	46·2	61·6	50·3	57·3
1912-1921	49·8	40·2	46·6	62·9	50·5	57·5

NOTES AND QUERIES

The Dry June of 1925

THE rainfall of June, 1925, was below the average everywhere except in the extreme north of Scotland. The deficiency was most marked in England and Wales and in Ireland where falls of 1 in. or more were confined to high land in the English Lake District, Connemara and the counties of Londonderry, Tyrone and Donegal. Over large areas in the southern half of England and Wales no measureable rain fell during the 32 days beginning on May 30th. The area with no rainfall in June appears to have been confined to England and Wales south of the latitude of Birmingham and to the west of a line from Brighton to Bedford.

At Camden Square (London) the fall of ·11 in. was the least amount recorded there in June since the record began in 1858, and the driest month since April, 1912, when only ·04 in. fell. The Rev. R. P. Dansey, of Kentchurch Rectory, Hereford, recorded his "first rainless month in 31 years' observations in Herefordshire and Shropshire." He draws attention to the fact that "the rivers did not get so low as on several previous occasions nor was the country so dried up, the year's rainfall up to the end of June being still 0·66 in. in excess of the average." The following notes from observers indicate the abnormality of the rainfall of the month: It was the driest June at Slough in Buckinghamshire in 52 years, and at St. Michael's on Wyre in Lancashire in 50 years. It was the driest calendar month at

Wolstaston Rectory in Shropshire in 60 years' record, at Newcastle in 57 years, at Mickleover, near Derby, in 55 years, and at Bramley, in Hampshire, in 54 years.

The fall for the month was less than 10 per cent. of the average over the whole of England and Wales, with the exception of part of the extreme north and the south-eastern counties from the Wash to Beachy Head, and also along the east coast of Ireland. The fall nowhere exceeded half the average in England and Wales and only locally in Ireland in the neighbourhood of Londonderry. In Scotland the percentage values increased fairly regularly from about 10 per cent. in the south to 118 per cent. at Achfary in Sutherlandshire. In the Thames Valley some rain fell generally on the 24th and 26th. The total fall for the month amounted to ·12 in. or 5 per cent. of the average. This constitutes a record for June for the Valley as a whole since comparable statistics became available in 1883, and the driest month since April, 1912, when the general fall was ·06 in.

So far as can be ascertained from the information already available the rainfall of June, 1925, over the British Isles as a whole was less than in June, 1921, and ranks about equal with that of the record dry month February, 1891. A similar statement holds for England and Wales. In Scotland the month was probably not as dry as July, 1913, and several other earlier months. In Ireland June, 1921, was drier. By the end of June the " absolute drought " had not equalled that of the famous spring drought of 1893 when in parts of Kent and Sussex no rain was measured for a period of 50 days. J.G.

The Comparison of Rainfall at Neighbouring Stations

In preparing rainfall statistics it is often necessary to calculate a normal for a given station for a longer period than is covered by the available observations. For example, an average rainfall map is being prepared for the period 1881 to 1915, and at one station, which we will call " A," observations did not commence until 1891. The recognised procedure in such cases is to select one or more neighbouring stations at which observations were taken over the full period, and to assume that the ratio between the annual or monthly rainfall at station " A " and that at the comparison stations is constant. This assumption is sometimes called Hann's Law. In our example we may suppose that at the comparison stations the average rainfall during the period 1891 to 1915 was 20·0 in. and that between 1881 and 1915 21·0 in. The average rainfall at station " A " for 1891 to 1915 is then multiplied by 21·0/20·0 and the result is considered to represent the average at station " A " for the period 1881 to 1915.

The validity of this process depends on the correctness of the assumption mentioned above, that the ratio between the rainfall

at "A" and at the comparison stations is constant. Hann* himself quotes annual figures for Lucerne and Basle which are nearly fifty miles apart and continues "One sees that the variations of the annual rainfall in general run parallel and that one may accordingly assume that the rainfall of a place between Lucerne and Basle or especially in the neighbourhood of one of these stations would similarly take part in the same variations." This assumption has worked well in practice in this country, in that it has never led to any obvious errors, but apparently it has never been categorically confirmed. For the two Scottish stations of Fort Augustus and Glenquoich a test shows that it is not strictly true. Fort Augustus lies at a height of 68 feet at the south-western end of Loch Ness, and Glenquoich, at a height of 569 feet, is 25 miles to the west-southwest. For the period 1884 to 1918 the average annual rainfall at Glenquoich was 2·51 times that at Fort Augustus, and according to the principle of proportionality, we should write—

Glenquoich rain = 2·51 × Fort Augustus rain...I.

For the two dry years 1889 and 1915, however, the ratio was 2·65, and for the two wet years 1903 and 1916 it was 2·25. A calculation by the method of least squares shows that the rainfall at Glenquoich can be derived from that at Fort Augustus more accurately than by the method of direct proportionality, if we write

Glenquoich rain = 1·64 × Fort Augustus rain + 39·0 in....II.

There are more raindays at Glenquoich than at Fort Augustus, and the additive figure of 39·0 in. presumably represents the days on which little or no rain fell at the latter station, while at the former the amount was appreciable.

In winter the relation between the two stations is similar to that for the year. Thus, for January:

Glenquoich rain = 1·91 × Fort Augustus rain + 3·74 in.

In summer, on the other hand, Hann's Law is very nearly correct; for July:

Glenquoich rain = 2·52 × Fort Augustus rain — 0·86 in.

The rainfall at Glenquoich for the two wet years 1903 and 1916, calculated from those at Fort Augustus by formula I are respectively 14 and 18 in. too high, while by formula II the errors are only — 4·8 and + 5·8 in. It seems that at the two stations compared a considerable improvement in the accuracy of interpolated values would be obtained by a modification of the assumption of direct proportionality. In this particular example the sites of the stations differ widely; at two stations similarly situated in an open plain with approximately the same number of raindays it is quite possible that the additive term would be very small, but the test, which takes very little time,

* Lehrbuch der Meteorologie, 3rd edition, p. 336.

would be worth making as a preliminary to all reductions from one station to another.

Unusually Severe Weather in 1684

IN the series of extracts, entitled "Early Science at Oxford," now being published in *Nature*, the following appeared in the issue for February 7th, 1925:—

> "*February 10th*, 1684/5. That Mr. Maunders, chaplain to Col. Luttrel, in Dorsetshire, Mr. Thomas, minister of Chard, and Dr. Tubervile of Salisbury, be asked what information they can give of ye late cold wind, which proved so fatal in Wiltshire, and Dorsetshire, about last Christmas."

Nature for March 7th, 1925, contained the sequel:

> "*March 10th*, 1684/5. Mr. Maunders speaking of ye dismall weather on ye 23rd of December last, says, that above eighty Persons were found killed by it, in Wiltshire and Dorsetshire. Some died suddenly, others by degrees: some, that escaped, were so tormented in their hands, and face (parts exposed to ye cold) that, as they recovered, and ye swellings abated, the skin peeled off, and they were some days without ye use of their limbes, and sometimes of their senses."

This exceptional occurrence is not recorded by Lowe in his *Natural Phenomena and Chronology of the Seasons*, nor is it mentioned by Sir Richard Gregory in *British Climate in Historic Times*. It would be interesting to know whether any records still exist which would throw further light on weather which appears to have been so exceptional for this country.

A Lost Opportunity

ON November 2nd, 1924, about 22h. 55m. a splendid meteor was seen in the western sky from Somerset and Devonshire. Many persons witnessed the outburst, which was of dazzling intensity and lit up the countryside with vivid effect. The fireball passed to the north-west, its luminous course began, when over Bude, at a height of about 69 miles, and it travelled seawards, disappearing far to the west of Lundy Island. A few minutes following the apparition, a loud and somewhat alarming detonation was heard by a number of people in the district near which the meteor passed. According to Mr. W. F. Denning, who is our greatest expert in such matters, there is no doubt but that the noise was occasioned by the explosion and disruption of the object. Unfortunately, few of the people who saw the apparition or heard the explosion made notes of the time, and Mr. Denning can only say that the interval between sight and sound averaged about 5 minutes.

Near the village of Hilton in Derbyshire, on April 4th, 1925, a bright red ball of fire was seen in the south-western sky about 21h. 40m. The whole countryside was lit up, and surrounding trees, fields and other objects could be seen as though it were daylight. The ball when first observed was at an angle of elevation of about 50°. As it fell it turned a light shade of green then dull red and disappeared. Altogether it lasted about 8 seconds. These facts were reported by two independent observers.

The object of this note is to point out that wireless has made the accurate timing of widespread observations a possibility. If a dozen of the people who saw the meteor on November 2nd had listened for the arrival of the sound, and noted the time to a second, information of great value would have been secured. The information is required because it would enable reliable estimates of the temperature at great heights to be made, for the time of travel of sound depends on the temperature of the air. There is good evidence that the average temperature 30 miles above ground is actually higher than in parts of the atmosphere with which we are familiar. Such a paradoxical idea should be tested as much as possible, and the timing of meteoric explosions is likely to provide one of the best tests. Some day we shall make our own explosions by sending up powerful rockets, but meanwhile use should be made of the opportunity presented to us by nature. This is one of the ways in which the great public which enjoys broadcasting can repay its debt to science.

A few words about time-keeping may not be out of place. In an ordinary watch or clock the seconds hand goes on steadily whilst the minute hand and hour hand are being set. If an attempt is made to set the minute-hand to the correct time, it will generally be found that the seconds hand and minute hand get out of step. If the hour hand is between II. and III. and the minute hand a third of the way from 33 to 34, whilst the seconds hand is at 49, what is the time by your watch? The best plan is to set the minute hand to be in step with the seconds hand. When you learn from the time-signal that your watch is 2 minutes 42 seconds fast, put the minute hand back 2 minutes and note that the watch is now 42 seconds fast. If you are systematic, you will note it in your diary. When you have made an observation of importance, check the error of the watch at the first opportunity, and if you are reporting the observation, give the time of the observation itself according to your watch, and also the errors of the watch as given by the time signals before and after the observations. The Greenwich Time Signal consists of six dots, the last of which marks the exact time. Mr. J. P. M. Prentice, of Redcroft, Stowmarket, Suffolk, is

Director of the Meteor Observing Section of the British Astronomical Association, and would be glad to have records of the time and bearing of all meteors, not only of the audible ones, though these are the more interesting at the moment.

St. Helena

Mr. A. L. C. Hands, the veteran observer at St. Helena, who has read the instruments daily and cared for the anemometer at that station for nearly thirty-four years is retiring. The station is near the summit of a hill, at a height of about 2,000 feet, and Mr. Hands, who has been suffering from ill-health lately, finds himself unable to continue this arduous climb in all weathers. The isolated station at St. Helena, situated in the south Atlantic " centre of action," has proved of great value in investigations of the meteorology of the globe and Mr. Hands has performed a great service for the science. There was at one time some fear that a successor would not be forthcoming and it is satisfactory to report that this fear has proved groundless. The observations will be carried on by Captain J. P. Mainwaring, late R.E.

Weather and Sugar Crops

In 1909 Mr. A. Walter, Director of the Royal Alfred Observatory, Mauritius, published a valuable study of the influence of meteorological conditions on the sugar crop of Mauritius. In this investigation the crops were correlated with a " wetness factor " formed by multiplying the mean daily rainfall by the number of rain days. Since it was realised that rainfall above a certain amount cannot have a proportional effect, an arbitrary limit of 0·50 in. per day was adopted, and the year 1896, in which the average rainfall exceeded this amount, was ignored. The crude rainfall figures gave a correlation coefficient of + 0·52 with crops, and the " wetness factor " a coefficient of + 0·70.

Mr. Walter has since continued his investigations, and now gives us the first part of his later results.* For the arbitrary " wetness factor " he has substituted the actual amount of moisture in the soil, determined by a series of experiments on the rate of drying of samples of soil under field conditions. From this curve of drying and the daily rainfall the moisture-content was calculated for each day during the whole period, 1892 to 1905, and the annual averages were correlated with the crops. The effect of temperature was also included, and partial correlation coefficients were obtained : crop-soil moisture (temperature

* Mauritius, Royal Alfred Observatory, Miscellaneous Publications, No. 5. *The Relation between sugar crops and weather.* By A. Walker, Port Louis, 1922.

constant), + 0·827; crop – temperature (soil moisture constant), + 0·310. This represents a great advance on the original "wetness factor," and, by discussing the soil moisture during each two-monthly period separately, a further improvement was obtained. From the amounts by which the observed crops fell below the calculated crops during four years in which the island was visited by cyclones, a complicated expression is derived for the damage done to the crops by winds exceeding forty miles an hour. The formulæ thus give a method of calculating the crop from the rainfall, temperature and wind velocity. The author recognises that the period of fourteen years is too short for completely reliable results, but after 1905 changes were introduced in the cultural conditions. The years 1905 to 1917 are being dealt with in a further memoir, and then the results for the whole period will be summarised.

Apia Observatory

FROM time to time brief accounts of the extension of the work carried out by the Apia Observatory (western Samoa) have appeared in the *Meteorological Magazine*. About two years ago it was made the headquarters of a weather service for the western Pacific. Now in response to the appeal for more rapid publication of meteorological data, a monthly summary containing daily and monthly values of pressure, temperature, precipitation, etc., at the Apia Observatory is being issued within a few days of the end of each month. The summaries started in January, 1925, and the Director, Mr. Thomson, is to be congratulated on the amount of meteorological detail concerning the Observatory which is received on the other side of the world in so short a time.

The Publication of Observations Made at the Observatories of the Meteorological Office

THE attention of librarians is called to the fact that the series of volumes published under the title *British Meteorological and Magnetic Yearbook* terminates with the issues for the year 1921. The *Weekly Weather Report* and the *Monthly Weather Report* are now regarded as separate publications. It has been mentioned previously that Observations at Stations of the First and Second Order, Part III., Section I., of the Yearbook has been discontinued. The Geophysical Journal and Hourly Values from Autographic Records, *i.e.*, Part III., Section II., and Part IV., of the *Yearbook* are being amalgamated in a single publication, to which the title *The Observatories' Year Book* has been assigned. The first volume of the new series, that giving data for 1922, is now in the press and will appear shortly.

Review

Die Ergebnisse der meteorologischen Beobachtungen der Deutschen Antarktischen Expedition 1911-1912. By E. Barkow. Edited by K. Knoch. (Veröff. Preuss. Met. Inst. Abh. vii. 6.) 4to., 13 × 10, pp. x. + 166. Berlin : Behrend and Co. 1924.

HERR BARKOW, the meteorologist on Filchner's expedition of 1911-12 to the Weddell Sea on the *Deutschland*, was engaged in the discussion of the meteorological data collected on the voyage when he died in 1923, and the work has been completed by Herr Knoch. Difficulties of publication have compelled a severe condensation of the original discussion and it may be on this account that the data have been dealt with throughout as if they had been obtained at a fixed station instead of on a ship sailing southward and then drifting northward in an ice-encumbered sea through some twenty degrees of latitude, the Antarctic circle coming nearly midway between the extreme positions. By dealing with monthly and seasonal means, irrespective of position, the authors certainly escape the main difficulty which confronted them, but at the same time their results lose much of their value from the regional point of view. Attention might well have been called more prominently to the fact that while the data for December, 1911, and December, 1912, came from the positions north of 63° S, January, 1912, between 62° and 77° S, those for February came almost entirely from south of 75° S, those for March to July from 75° to 70° S, and those for August to November between 70° and 63° S. Probably the March to July results are the most homogeneous and give a fair idea of the meteorological conditions of the Weddell Sea in winter. It is to be deplored that the meteorology of the *Deutschland* and of the *Endurance* could not have been worked up together ; but on the other hand the discussion of Shackleton's results to which we look forward will be greatly helped by the careful elaboration of Filchner's work now before us.

The daily and yearly march of pressure, temperature, humidity, wind and clouds is dealt with systematically and the duration of sunshine, the duration and amount of precipitation and the temperature of the floe-ice at various depths are also set forth in monthly and seasonal tables. The excellent series of upper air observations by means of kites, captive and pilot balloons were a valuable part of the meteorological work of the expedition and are treated in considerable detail. There is also a daily weather summary, and the memoir concludes with a short dissertation on the circulation of the atmosphere in the Antarctic.

Throughout the discussion of the data reference is made to the work of the *Gauss*, to Nordenskjöld's observations at Snow

Hill and to Amundsen's at Framheim; but when this part of the work was being dealt with Dr. Simpson's report on the meteorology of the *Terra Nova* expedition was not available, and is only referred to by notes added on revision. In the section on Atmospheric Circulation, however, Dr. Simpson's work was fully utilized and the authors do not hesitate to accept his conclusions in many cases in preference to those of their countryman Meinardus.

Herr Barkow thus summarizes his view of Antarctic atmospheric circulation—"The circulation over the Antarctic continent is dominated by an anticyclonic cap of air which probably flows outward in a series of waves moving in a south to north direction. Above this cap of cold air there is a cyclonic stratum connected with the circulation of temperate latitudes and in this wandering depressions travel in a west to east direction. The two air-systems mutually influence each other; on the whole the lower system dominates the upper at least so far as atmospheric pressure is concerned. The surface winds are dominated on the whole by the lower system for the most part on the continent and in less degree as the distance from land increases. In the Cirrus region, and especially in the stratosphere, cloud movements appear to show that there is a current of air moving right across the continent from the Indian Ocean to the region of the West Antarctic as indicated by the northern component of cirrus-movement in the former region and the southern component in the latter." Herr Barkow says that he concurs in Professor Hobb's conception of the formation of a south polar glacial anticyclone.

The Prussian Meteorological Institute is to be congratulated on bringing out this memoir in spite of difficulties of compilation and printing more serious even than the difficulties of the polar ice which forced the *Deutschland* so far from the path laid down "according to plan."

HUGH ROBERT MILL.

The Weather of June, 1925

THE outstanding feature of the weather of June was the scarcity of rainfall; less rain being measured in England and Wales than in the record dry June of 1921. In many districts in south-west and south England and south Wales there was no rain at all. During the first few days of the month depressions near Iceland caused moderate to fresh west to south-west winds over the greater part of the British Isles, with slight showers of rain in the south and slight to moderate rain in the north: 17 mm. were measured at Eskdalemuir (Dumfries) on the 2nd, and at Achnashellach (Ross-shire) both on the 1st and 2nd. Ground

frosts were experienced in some parts, a grass minimum temperature of 26° F. being recorded at Rounton (York) on the 2nd. The ridge of high pressure however, extending from the Azores, spread gradually north-eastwards, and by the 4th an anticyclone lay over England and the Netherlands. Temperature rose considerably, and for about a fortnight warm sunny weather prevailed. Readings above 80° F. occurred in many places, 88° F. being reached at London (Camden Square) on the 11th, and 86° F. as far north as Durham on the 10th. At Eskdalemuir 82° F. on the 10th was the highest reading taken there in June since records began in 1910. Between 14 and 15 hours of bright sunshine were experienced on most days, and as much as 16·0 hours were registered at Stornoway on the 8th. Mist and fog occurred on several days along the east coast of Great Britain. Meanwhile, the anticyclone, after having passed to Scandinavia, had begun to withdraw westwards to the Atlantic. On the 13th to 14th a depression moved south-eastwards from Iceland to the Baltic, and cool northerly breezes were associated with a temporary drop in temperature. On the 15th the winds backed to west and temperature again rose above 80° F. in a few places, but by the 17th pressure had increased near Iceland and north-west to north winds prevailed during the next ten days. Warm sunny weather continued to be experienced generally in the western districts of Great Britain—78° was the maximum at Kilmarnock on the 24th—but in the eastern districts the weather was cloudy and cool, especially on the 24th, when a maximum temperature of 49° F. was recorded at Rounton (York). Slight rain occurred locally, the largest measurements being registered on the east coast. Between the 27th and the 30th the anticyclone passed southwards across the British Isles and the weather became generally fine and warm. In north-west Scotland and north-west Ireland, however, much cloud developed, and rain fell locally. Total sunshine for the month reached record figures in several places. At Falmouth Observatory, 375 hours exceeded all previous records there by nearly 30 hours.

Pressure was above normal over the western coasts of Europe, the British Isles, the greater part of the North Atlantic and at Spitsbergen, the excess exceeding 5 mb. over Ireland and western England. Over the greater part of Scandinavia, Iceland, Jan Mayen and the western Mediterranean pressure was somewhat below normal. This distribution favoured northerly winds over the North Sea and the adjacent coasts. Temperature was generally about normal over western Europe but more than 2° F. in excess in the extreme north. With the exception of northern Scandinavia the rainfall over western Europe was very scanty, the deficit amounting to 90 mm. at Zurich, 54 mm. at

[*continued on p.* 156

Rainfall: June, 1925: England and Wales

CO.	STATION.	In.	mm.	Per-cent. of Av.	CO.	STATION.	In.	mm.	Per-cent of Av.
Lond.	Camden Square.....	·11	3	5	*War.*	Birminghm, Edgbaston	·34	9	15
Sur .	Reigate, Hartswood...	·10	3	5	*Leics*	Thornton Reservoir ..	·03	1	1
Kent.	Tenterden, View Tower	·18	5	9	,, .	Belvoir Castle.....	·13	3	7
,, .	Folkestone, Boro. San.	·54	14	...	*Rut .*	Ridlington.....	·06	1	...
,, .	Broadstairs, St. Peter's	·72	18	41	*Linc.*	Boston, Skirbeck	·20	5	11
,, .	Sevenoaks, Speldhurst.	·22	6	...	,, .	Lincoln, Sessions House	·05	1	2
Sus .	Patching Farm.....	·09	2	4	,, .	Skegness, Estate Office.	·13	3	7
,, .	Brighton, Old Steyne .	·08	2	5	,, .	Louth, Westgate	·08	2	4
,, .	Tottingworth Park....	·22	6	10	,, .	Brigg	·06	1	3
Hants	Ventnor, Roy. Nat. Hos.	·00	0	0	*Notts.*	Worksop, Hodsock....	·11	3	6
,, .	Fordingbridge, Oaklnds	·01	0	1	*Derby*	Mickleover, Clyde Ho..	·08	2	3
,, .	Ovington Rectory	·00	0	0	,, .	Buxton, Devon. Hos...	·17	5	5
,, .	Sherborne St. John Rec.	·00	0	0	*Ches.*	Runcorn, Weston Pt...	·02	1	1
Berks	Wellington College...	·00	0	0	,, ..	Nantwich, Dorfold Hall	·05	1	...
,, .	Newbury, Greenham..	·00	0	0	*Lancs*	Manchester, Whit. Pk.	·06	1	2
Herts.	Bennington House....	·32	8	16	,, ..	Stonyhurst College....	·27	7	9
Bucks	High Wycombe	·00	0	0	,, ..	Southport, Hesketh...	·07	2	3
Oxf..	Oxford, Mag. College..	·05	1	2	,, ..	Lancaster, Strathspey.	·49	12	...
Nor .	Pitsford, Sedgebrook..	·00	0	0	*Yorks*	Sedbergh, Akay	·35	9	11
,, .	Eye, Northolm.....	·08	2	...	,, .	Wath-upon-Dearne ...	·12	3	5
Beds.	Woburn, Crawley Mill.	·06	1	3	,, .	Bradford, Lister Pk...	·08	2	3
Cam.	Cambridge, Bot. Gdns.	·43	11	20	,, .	Wetherby, Ribston H..	·00	0	0
Essex	Chelmsford, County Lab	·38	10	20	,, .	Hull, Pearson Park ...	·05	1	2
,, .	Lexden, Hill House...	·30	8	...	,, .	Holme-on-Spalding ...	·09	2	...
Suff .	Hawkedon Rectory ...	·58	15	28	,, .	West Witton, Ivy Ho..	·09	2	...
,, .	Haughley House.....	·45	11	...	,, .	Felixkirk, Mt. St. John	·10	3	5
Norf.	Beccles, Geldeston....	·74	19	41	,, .	Pickering, Hungate ...	·03	1	...
,, .	Norwich, Eaton	·61	15	32	,, .	Scarborough.....	·18	5	10
,, .	Blakeney	·62	16	33	,, .	Middlesbrough	·08	2	4
,, .	Swaffham	·64	16	30	,, .	Baldersdale, Hury Res.	·09	2	4
Wilts.	Devizes, Highclere....	·10	3	4	*Durh.*	Ushaw College	·23	6	11
,, .	Bishops Cannings	·07	2	3	*Nor .*	Newcastle, Town Moor.	·04	1	2
Dor .	Evershot, Melbury Ho.	·07	2	3	,, .	Bellingham, Highgreen	·16	4	...
,, .	Weymouth, Westham..	...	..	...	,, .	Lilburn Tower Gdns...	·13	3	...
,, .	Shaftesbury, Abbey Ho.	·02	1	1	*Cumb*	Geltsdale.....	·45	11	...
Devon	Plymouth, The Hoe...	·01	0	0	,, .	Carlisle, Scaleby Hall .	·29	7	12
,, .	Polapit Tamar	·01	0	0	,, .	Seathwaite M.....	·46	12	7
,, .	Ashburton, Druid Ho..	·00	0	0	*Glam.*	Cardiff, Ely P. Stn.....	·06	1	2
,, .	Cullompton	·20	5	9	,, .	Treherbert, Tynywaun	41	10	...
,, .	Sidmouth, Sidmount ..	·04	1	2	*Carm*	Carmarthen Friary....	·02	1	1
,, .	Filleigh, Castle Hill ...	·01	0	...	,, .	Llanwrda, Dolaucothy.	·08	2	2
,, .	Barnstaple, N.Dev.Ath.	·00	0	0	*Pemb*	Haverfordwest, School	·00	0	0
Corn.	Redruth, Trewirgie ...	·00	0	0	*Card.*	Gogerddan.....	·05	1	2
,, .	Penzance, Morrab Gdn.	·00	0	0	,, .	Cardigan, County Sch. .	·03	1	...
,, .	St. Austell, Trevarna..	·03	1	1	*Brec .*	Crickhowell, Talymaes	·10	3	...
Soms	Chewton Mendip	·01	0	0	*Rad .*	Birm. W. W. Tyrmynydd	·11	3	3
,, .	Street, Hind Hayes ...	·06	1	...	*Mont.*	Lake Vyrnwy	·00	0	...
Glos..	Clifton College	·00	0	0	*Denb.*	Llangynhafal	·10	3	...
,,	Cirencester	·13	3	5	*Mer .*	Dolgelly, Bryntirion..	·19	5	5
Here.	Ross, Birchlea	·00	0	0	*Carn.*	Llandudno	·08	2	4
,, .	Ledbury, Underdown.	·00	0	0	,, .	Snowdon, L. Llydaw 9	·57	15	...
Salop	Church Stretton.....	·03	1	1	*Ang .*	Holyhead, Salt Island.	·05	1	2
,, .	Shifnal, Hatton Grange	·03	1	1	,, .	Lligwy	·01	0	...
Staff.	Tean, The Heath Ho...	·07	2	3	*Isle of Man*				
Worc.	Ombersley, Holt Lock.	·05	1	2		Douglas, Boro' Cem...	·11	3	4
,, .	Blockley, Upton Wold.	·21	5	8	*Guernsey*				
War.	Farnborough.....	·10	3	4		St. Peter P't, Grange Rd	·00	0	0

Rainfall: June, 1925: Scotland and Ireland

CO.	STATION	In.	mm.	Per-cent. of Av.	CO.	STATION.	In.	mm.	Per-cent of Av.
Wigt.	Stoneykirk, Ardwell Ho	·42	11	17	*Suth.*	Loch More, Achtary ...	4·37	111	118
,, .	Pt. William, Monreith .	·43	11	...	*Caith*	Wick	1·36	35	76
Kirk.	Carsphairn, Shiel.	·47	12	...	*Ork .*	Pomona, Deerness	1·46	37	79
,, .	Dumfries, Cargen.....	·23	6	8	*Shet .*	Lerwick	1·00	25	56
Dum	Drumlanrig	·31	8	13					
Roxb	Branxholme	·68	17	30	*Cork.*	Caheragh Rectory	·50	13	...
Selk .	Ettrick Manse.....	·85	22	...	,, ..	Dunmanway Rectory.	·48	12	14
Berk.	Marchmont House	·28	7	12	,, ..	Ballinacurra	·43	11	16
Hadd	North Berwick Res....	·70	18	42	,, ..	Glanmire, Lota Lo. ...	·70	18	26
Midl	Edinburgh, Roy. Obs..	·46	12	24	*Kerry*	Valencia Obsy.	·31	8	10
Lan .	Biggar	·36	9	17	,, .	Gearahameen	·20	5	...
Ayr .	Kilmarnock, Agric. C..	·44	11	20	,, .	Killarney Asylum.....	·27	7	9
,, .	Girvan, Pinmore.....	·55	14	19	,, .	Darrynane Abbey	·28	7	9
Renf.	Glasgow, Queen's Pk..	·35	9	15	*Wat .*	Waterford, Brook Lo..	·42	11	16
,, .	Greenock, Prospect H..	1·53	39	46	*Tip .*	Nenagh, Cas. Lough...	·70	18	29
Bute.	Rothesay, Ardencraig.	1·40	36	46	,, .	Tipperary	·49	12	...
,, .	Dougarie Lodge	1·20	31	...	,, .	Cashel, Ballinamona ..	·42	11	18
Arg .	Ardgour House	3·24	82	...	*Lim .*	Foynes, Coolnanes	·20	5	8
,, .	Manse of Glenorchy..	2·53	64	...	,, .	Castleconnell Rec.	·64	16	...
,, .	Oban	1·77	45	...	*Clare*	Inagh, Mount Callan ..	·34	9	...
,, .	Poltalloch				,, .	Broadford, Hurdlest'n.	·46	12	...
,, .	Inveraray Castle.....	2·07	53	52	*Wexf*	Newtownbarry	·50	13	...
,, .	Islay, Eallabus.....	1·67	42	64	,, .	Gorey, Courtown Ho...	·22	6	9
,, .	Mull, Benmore	5·30	135	...	*Kilk.*	Kilkenny Castle	·35	9	14
Kinr.	Loch Leven Sluice	·33	8	15	*Wic .*	Rathnew, Clonmannon	·10	3	...
Perth	Loch Dhu	1·00	25	24	*Carl .*	Hacketstown Rectory .	·43	11	15
,, ..	Balquhidder, Stronvar.	·46	12	12	*QCo..*	Blandsfort House.....	·29	7	11
,, ..	Crieff, Strathearn Hyd.	·51	13	19	,,	Mountmellick	·50	13	
,, ..	Blair Castle Gardens ..	·50	13	25	*KCo .*	Birr Castle.....	·55	14	24
,, .	Coupar Angus School..	·35	9	19	*Dubl.*	Dublin, FitzWm. Sq...	·26	7	13
Forf.	Dundee, E. Necropolis.	·61	15	34	,, .	Balbriggan, Ardgillan .	·16	4	8
,, .	Pearsie House.....	·60	15	...	*Me'th*	Drogheda, Mornington	·33	8	...
,, .	Montrose, Sunnyside..	·74	19	45	,, .	Kells, Headfort.....	·55	14	21
Aber.	Braemar Bank	·45	11	24	*W.M*	Mullingar, Belvedere .	·79	20	30
,, .	Logie Coldstone Sch. ..	·67	17	34	*Long*	Castle Forbes Gdns....	·66	17	26
,, .	Aberdeen, Cranford Ho	·			*Gal .*	Ballynahinch Castle ..	·86	22	24
,, .	Fyvie Castle	1·12	28	...	*Mayo*	Mallaranny.....	1·72	44	...
Mor .	Gordon Castle.....	1·02	26	50	,, .	Westport House.....	·33	8	12
,,	Grantown-on-Spey....	·77	20	34	,, .	Delphi Lodge	1·67	42	...
Na .	Nairn, Delnies.....	·51	13	29	*Sligo*	Markree Obsy.	·75	19	26
Inv..	Ben Alder Lodge	1·22	31	...	*Cav'n*	Belturbet, Cloverhill..	·94	24	39
,, .	Kingussie, The Birches	·55	14	...	*Ferm*	Enniskillen, Portora ..	·58	15	...
,, .	Loch Quoich, Loan....	3·10	79	...	*Arm.*	Armagh Obsy.	1·08	27	43
,, .	Glenquoich	3·57	91	73	*Down*	Warrenpoint	·36	9	...
,, .	Inverness, Culduthel R.	·33	8	...	,, .	Seaforde	·22	6	8
,, .	Arisaig, Faire-na-Squir	2·90	74	...	,, .	Donaghadee, C. Stn...	·30	8	13
,, .	Fort William.....	1·83	47	52	,, .	Banbridge, Milltown .	·79	20	31
,, .	Skye, Dunvegan.....	1·60	41	...	*Antr.*	Belfast, Cavehill Rd. .	·60	15	...
,, .	Barra, Castlebay	·35	9	...	,, .	Glenarm Castle.....	·85	22	...
R&C	Alness, Ardross Cas. ..	·63	16	28	,, .	Ballymena, Harryville	1·23	31	42
,, .	Ullapool.....	1·77	45	...	*Lon .*	Londonderry, Creggan	1·57	40	56
,, .	Torridon, Bendamph..	2·60	66	64	*Tyr .*	Donaghmore	·94	24	...
,, .	Achnashellach	3·25	83	...	,, .	Omagh, Edenfel	·80	20	28
,, .	Stornoway	·98	25	42	*Don .*	Malin Head	·76	19	36
Suth.	Lairg	·88	22	...	,, .	Rathmullen.....	·69	17	...
,, .	Tongue Manse.....	1·68	43	82	,, .	Dunfanaghy	·62	16	22
,, .	Melvich School.....	1·03	26	53	,, .	Killybegs, Rockmount .	1·33	34	35

Climatological Table for the British Empire, January, 1925

STATIONS	PRESSURE		TEMPERATURE							Relative Humidity	Mean Cloud Am'nt	PRECIPITATION			BRIGHT SUNSHINE	
			Absolute		Mean Values				Mean							
	Mean of Day M.S.L	Diff. from Normal	Max.	Min.	Max.	Min.	½ max. and min.	Diff. from Normal	Wet Bulb.			Am'nt	Diff. from Normal	Days	Hours per day	Percentage of possible
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0—10	mm.	mm.			
London, Kew Obsy.	1024·3	+ 6·7	55	27	46 9	36·8	41·9	+ 3·0	39·1	90	8·3	45	0	15	1·2	15
Gibraltar	1029·8	+ 8·6	63	43	60 5	51·4	55·9	+ 1·1	49·9	78	6·7	3	−126	3	...	...
Malta	1028·3	+10·7	64	48	59·0	51·7	55·4	+ 0·1	49·1	72	5·6	32	− 50	12	6·0	61
Sierra Leone	1013·3	+ 2·1	91	65	88·3	69·7	79·0	− 2·5	70·0	63	2·1	0	− 11	0	...	...
Lagos, Nigeria	1009·8	− 0·1	89	63	86·8	70·1	78·5	− 2·5	67·6	69	5·1	38	+ 10	1	...	...
Kaduna, Nigeria	1017·4	+ 5·8	89	...	82·1	...	...	...	54·2	47	1·2	0	0	0	...	...
Zomba, Nyasaland	1006·0	− 2·5	85	61	80·2	64·5	72·3	− 0·4	...	92	9·5	391	+112	28	...	...
Salisbury, Rhodesia	1005·6	− 3·3	80	50	75·2	60·2	67·7	− 1·8	63·0	78	7·5	296	+ 95	25	4·4	34
Cape Town	1013·8	+ 0·6	89	49	79·6	59·8	69·7	− 0·1	62·5	70	2·4	15	− 3	4	...	...
Johannesburg	1009·8	− 0·8	84	46	75·4	55·3	65·3	− 0·9	58·1	72	5·6	129	− 30	17	7·3	54
Mauritius	1011·6	− 0·3	88	68	85·5	72·7	79·1	− 0·2	75·0	68	6·2	150	− 47	19	9·0	69
Bloemfontein	...	...	91	47	85·6	59·1	72·3	− 0·9	63·1	62	3·5	72	− 30	9	...	...
Calcutta, Alipore Obsy.	1012·8	− 2·4	82	47	75·5	56·0	65·7	− 0·7	56·5	86	4·0	19	+ 10	1*	...	...
Bombay	1011·9	− 1·7	86	56	81·1	65·2	73·1	− 2·2	61·4	68	1·9	0	− 3	0*	...	...
Madras	1011·8	− 2·3	88	60	84·1	66·0	75·1	− 1·0	69·9	88	3·8	34	− 1	2*	...	...
Colombo, Ceylon	1009·4	− 2·1	89	65	84·8	70·2	77·5	− 1·6	73·5	73	4·9	90	+ 1	12	7·0	59
Hong Kong	1017·8	− 2·0	75	41	61·1	53·3	57·2	− 3·0	52·6	77	8·3	110	+ 75	12	2·9	27
Sandakan	...	...	88	72	85·4	74·4	79·9	0·0	75·5	84	...	682	+213	17	...	...
Sydney	1013·1	+ 0·6	98	53	75·5	63·4	69·5	− 2·1	65·2	70	7·8	120	+ 27	15	5·3	38
Melbourne	1013·3	+ 0·4	97	47	76·7	56·1	66·4	− 1·1	59·2	61	5·4	81	+ 34	9	8·4	58
Adelaide	1013·2	+ 0·2	96	52	83·6	61·3	72·5	− 1·6	60·0	43	4·7	10	− 8	4	9·9	70
Perth, W. Australia	1011·8	− 0·7	95	49	83·3	61·4	72·3	− 1·6	61·6	50	3·0	17	+ 9	4	10·5	76
Coolgardie	1011·1	− 0·3	103	48	85·9	60·3	73·1	− 4·3	58·5	46	4·7	11	− 1	4	...	...
Brisbane	1011·8	+ 0·4	95	62	81·7	67·0	74·3	− 2·9	69·2	70	7·1	190	+ 27	18	5·1	38
Hobart, Tasmania	1013·5	+ 3·2	87	42	68·8	51·7	60·3	− 2·0	54·5	63	6·7	51	+ 6	13	6·8	46
Wellington, N.Z.	1016·2	+ 3·4	78	46	70·2	56·5	63·3	+ 0·9	58·6	68	6·2	95	+ 11	9	7·3	50
Suva, Fiji	1007·9	+ 0·2	90	69	87·7	71·7	79·7	− 0·2	75·6	77	5·9	360	+ 88	23	...	...
Apia, Samoa	1007·8	− 0·1	88	73	84·7	74·6	79·7	+ 0·7	76·7	74	7·0	311	−116	19	4·6	36
Kingston, Jamaica	1015·8	+ 0·7	89	62	85·4	66·3	75·9	− 0·9	64·4	84	2·0	9	− 15	3	...	...
Grenada, W.I.	1015·4	+ 2·6	83	67	80·6	70·4	75·5	− 1·5	71·0	75	4·0	103	− 10	23	...	...
Toronto	1021·9	+ 4·5	40	−11	28·3	12·4	20·3	− 1·8	16·6	64	7·7	51	− 22	17	2·4	26
Winnipeg	1020·3	+ 0·5	34	−26	8·0	−7·1	0·5	+ 4·9	...	...	5·0	41	+ 22	12	2·8	33
St. John, N.B.	1019·4	+ 3·7	41	−19	19·4	3·5	11·5	− 7·7	7·7	...	4·7	120	− 2	13	4·6	51
Victoria, B.C.	1015·7	+ 0·4	50	31	44·1	37·6	40·9	+ 0·8	38·9	92	8·7	127	+ 12	25	2·0	23

* For Indian stations a rain day is a day on which 0·1 in. (2·5 mm.) or more rain has fallen.

Reference Table.—Climatological Table for the British Empire.

STATIONS.	Lat.	Long.	Height above M.S.L.	Hour of Observation.*	AUTHORITY.	Period of Normals. Pressure.	Temp.	Rainfall.
			Ft.					
London, Kew Obsy	51°28′N	0°19′W	34	7	Meteorological Office, Air Ministry, London	'81-'15	'81-'15	'81-'15
Gibraltar	36° 6′N	5°21′W	53	7	Colonial Secretary, Gibltr.	'52-'20	'52-'20	'52-'20
Malta	35°53′N	14°30′E	185	7	Meteorological Office, Air Ministry, London	'52-'23	'53-'23	'53-'23
Sierra Leone	8°29′N	13° 9′W	224	9	Medical and Sanitary Department, Freetown	'91-'20	'75-'20	'47-'51 '75-'20
Lagos, Nigeria	6°27′N	3°24′E	13	9	Surveyor-General, Lagos	'91-'15	'86-'00 '06-'15	'86-'19
Kaduna, Nigeria	10°32′N	7°25′E	2,088	9	Surveyor-General, Lagos	('91-'20)	('07-'23)	('14-'24)
Zomba, Nyasaland	15°23′S	35°18′E	3,270	9	Director of Agriculture	'99-'20	'92-'20	'92-'20
Salisbury, Rhodesia	17°48′S	31° 5′E	4,860	9	Hydrographic Engineer	'97-'23	'98-'03 '07-'20	'97-'20
Cape Town	33°56′S	18°29′E	40	8½	H.M. Astronomer	'84-'20	'84-'20	'84-'20
Johannesburg	26°11′S	28° 4′E	5,925	8½	ChiefMeteorologist,Pretoria	'04-'20	'04-'19	'88-'13
Mauritius	20° 6′S	57°33′E	181	9	Royal Alfred Observatory	'61-'19	'61-'19	'61-'19
Bloemfontein	29° 7′S	26°13′E	4,696	8½	G. H. Schepers, Esq., Grey College	'70-'84	'81-'99 '03-'06	'78-'99 '03-'13
Calcutta, Alipore Observatory	22°36′N	88°23′E	21	8	Director-General of Observatories, Simla	'89-'10	'78-'10	43 yrs.
Bombay	18°54′N	72°49′E	37	8	Do. do.	'47-'16	'75-'16	'47-'16
Madras	13° 4′N	80°14′E	22	8	Do. do.	'89-'20	43 yrs.	43 yrs.
Colombo, Ceylon	6°54′N	79°53′E	24	9½	Surveyor-General,Colombo	'12-'24	'08-'24	'08-'24
Hong Kong	22°18′N	114°10′E	109	9	Director, Royal Obsy.	'84-'18	'84-'18	'84-'18
Sandakan	5°50′N	118° 7′E	—	9	Principal Medical Officer	—	'79-'95 '05-'20	'79-'95 '05-'20
Sydney	33°52′S	151°13′E	138	9	Commonwealth Meteorologist, Melbourne	'59-'22	'59-'22	'59-'22
Melbourne	37°49′S	144°58′E	115	9	Do. do.	'58-'19	'56-'19	'56-'19
Adelaide	34°56′S	138°35′E	140	9	Do. do.	'57-'18	'57-'18	'39-'19
Perth, W.Australia	31°57′S	115°51′E	197	9	Do. do.	'85-'21	'97-'21	'76-'21
Coolgardie	30°57′S	121°10′E	1,389	9	Do. do.	'97-'19	'97-'19	'93-'19
Brisbane	27°28′S	153° 2′E	125	9	Do. do.	'87-'22	'87-'22	'52-'22
Hobart, Tasmania	42°53′S	147°20′E	177	9	Do. do.	'85-'19	'71-'19	'41-'79 '82-'19
Wellington, N.Z.	41°16′S	174°46′E	10	9	Meteorological Office, Wellington	'65-'17	56 yrs.	59 yrs.
Suva, Fiji	18° 8′S	178°26′E	20	9	Superintendent, Department of Agriculture	'86-'16	'86-'18	'86-'18
Apia, Samoa	13°48′S	171°46′W	7	9	The Director, Apia Obsy.	'90-'23	'90-'23	('90-'23)
Kingston, Jamaica	17°58′N	76°48′W	111	7	Government Meteorologist	'81-'98 '08-'22	'80-'99 '07-'18	'70 '72-'18
Grenada, W.I.	12° 5′N	61°46′W	509	9	Superintendent of Prisons, Richmond Hill	('76-'15)	'87 '91-'18	'87 '91-'18
Toronto	43°40′N	79°24′W	379	8	Director, Meteorological Service of Canada	'00-'18	78 yrs.	70 yrs.
Winnipeg	49°53′N	97° 7′W	760	7	Do. do.	'00-'18	45 yrs.	'75-'14
St. John, N.B.	45°17′N	66° 4′W	119	9	Do. do.	'02-'18	45 yrs.	'61-'10
Victoria, B.C.	48°24′N	123°19′W	230	5	Do. do.	'00-'18	29 yrs.	'81-'10

* Local or zone time.

NOTES :—

From January, 1925, the mean wet bulb, relative humidity and mean cloud amount refer to the morning hour of observation only. The pressure is reduced to mean of day as hitherto.

Salisbury, Rhodesia. The data refer to Department of Agriculture (4,860 ft.) from January, 1924. Diffs. from normal pressure refer to the Gaol station (4,825 ft.) until September, 1924, and then to the Department of Agriculture.

Hong Kong. Observations refer to 9h, 120th meridian time for January to April, 1925, and to 9h, local time from May, 1925, onwards.

Apia, Samoa. First included in June, 1924.

Continued from p. 151.

London. Heavy rain and thunderstorms occurred locally in southern France on the 9th, and thunderstorms caused much damage to the crops in Switzerland on the 13th to 15th. Towards the end of the month the drought in central Europe ended and heavy rain fell. This was followed by a drop in temperature. A landslide occurred on the bank of the Rhine near St. Goar, and fifteen villages were flooded by the overflowing of the Dniester in Poland. Snow occurred on the Alps down to the 5,400 ft. level, and in the Abruzzi four villages were almost destroyed owing to the heavy rains there. In Sweden pressure was below normal, and rainfall (except in the central districts) above normal. Heavy thundershowers occured locally on the 20th to 27th.

The northern part of the coast of Labrador was still blocked with ice by the middle of the month, making fishery operations difficult. A heat wave lasting about 4 days passed across the middle and eastern districts of the United States and across eastern Canada in the early part of the month. Temperatures of 100° F. were registered in several places on the 5th and 6th, e.g., Philadelphia, Baltimore. In Canada 98° F. occurred at London (Ontario). Though these heat records do not exceed those often reached in midsummer they are exceptional for June. During the same period keen frosts occurred in Idaho. At Yuma (Arizona) a maximum temperature of 112° F. was recorded on the 21st. Many people were drowned and several hamlets destroyed in the Isthmus of Tehuantepec (Mexico) through the overflowing of the Tehuantepec and Perros Rivers.

The chief crops in Angola, W. Africa, have suffered considerably owing to drought. During the last days of the month a severe gale was experienced on Lake Victoria.

Heavy rains and high winds in Malabar are causing anxiety lest the disastrous floods of last year should be repeated.

The rainfall in Australia was below normal, except in New South Wales and the Queensland coastal districts where floods occurred. Flood waters on the Murrumbidgee reached Hay by the 12th.

The special message from Brazil states that the rainfall was scanty over the whole country being 13 mm., 62 mm. and 44 mm. below normal in the northern, central and southern districts respectively. Fewer anticyclones passed across the country than in the previous month but the weather was unusually cold in the central and southern regions. The condition of the crops was generally good though the lack of rain was affecting some of them. Pressure at Rio de Janeiro was 1mb. above normal and temperature 0·9° F. below normal.

Rainfall June, 1925—General Distribution

England and Wales ..	6	per cent. of the average 1881-1915.
Scotland	39	
Ireland	23	
British Isles	18	